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## OUR IRON-CLAD CIVILIZATION

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### MEAGER RESOURCES OF EARLY CENTERS OF CIVILIZATION

OUR civilization is inherited from peoples who grew up in Southwestern Asia and the Mediterranean lands, regions singularly destitute of mineral wealth. Here intellectual progress far outran material progress.

The power of thought reached as great a height 2,500 years ago as it has ever attained. The scope of the mind's activities has broadened with the accumulation of knowledge but its creative power is not greater. The masters of to-day write no better literature, think no loftier thoughts, build no nobler buildings than the masters of the ancient world.

The intellectual achievements of man, as distinguished from his material achievements, find expression in the products of thought, in poetry, philosophy, religion, literature. Such attainments, depending mainly upon the creative power of the human mind, are possible in any environment which is friendly to physical and mental vigor. The essential qualities of genius may develop in an environment of meager material resources, as they did in Egypt, Babylonia, Palestine, Phœnicia and still more notably in Greece. In fact, all these centers of human development were in regions relatively poor in natural resources. The flood-plains were agriculturally rich, but Palestine, Phœnicia and Greece were poor. Italy was by no means a rich land.

### MATERIAL ASPECTS OF CIVILIZATION GOVERNED BY KIND OF MATERIALS AVAILABLE

But with the material expressions of civilization the situation is different; in each country they are governed by the materials which are available. Such sculpture as Greece produced was possible only in a superlatively gifted people; but sculpture never could attain high perfection in any land where pure white marble was unknown. Marble is found in nearly every country, but marble of such whiteness and texture, such freedom from the slightest flaw, such velvety softness and translucence

of luster was found only in the quarries of Greece. The peerless marble did not produce Greek sculpture—Greek genius did that; the marble simply made it possible. Absolutely no other stone has the combination of qualities which could lure man on to such achievements. The resources included in the geographical environment of a people, or readily obtainable by them, supply the materials in which genius embodies its dreams. If parian marble is a part of the environment, it becomes possible for genius to express itself in sculpture; the environment does not decree that man shall do great things in marble, it decrees only that he may. The environment is permissive, not mandatory.

#### STONE A MATERIAL OF RESTRICTED UTILITY

Man has had to evolve his architecture and make his tools and weapons by using the materials which he could get and could work. Wood, stone and the metals have been the materials at his disposal. Great achievements could not be executed in wood; it is too weak and too perishable. Stone is enduring, but it lends itself to a limited number of uses—mainly buildings and other structures. The Romans, master builders and road makers, accomplished wonders in the one enduring material which they had in abundance—stone. There is no reason to doubt that the Egyptians and the Romans would have done great things in metals if they had had them in sufficient quantities.

Stupendous as are the pyramids, the temples of Karnak or the Great Wall of China; veritable “frozen music” as are the medieval cathedrals, the fact remains that they are passive, stationary objects challenging man’s admiration and veneration; they are not mechanisms that multiply his efficiency, his power of production, or his power of further achievement. Had the materials at the service of the human race been only those in kind and quantity which the Mediterranean peoples had at their command, the story of mankind would have been so utterly unlike the story as it is, that it would not seem to be the record of the same world.

#### EARTH’S CRUST SUPPLIES ONLY TWO METALS IN ABUNDANCE

Eight chemical elements<sup>1</sup> make up 98 per cent. of the earth’s

<sup>1</sup> Oxygen . . . . .47.13	Iron . . . . .4.71	Sodium . . . . .268
Silicon . . . . .27.89	Calcium . . . . .3.53	Magnesium . . . . .2.64
Aluminum . . . . .8.13	Potassium . . . . .2.35	(Kemp. <i>Ec. Geol.</i> 1:699)

crust, but only two of these are metals of sufficient abundance to act as a directing influence in the world's material progress. They are iron, which forms over four and one half per cent. of the crust of the earth, and aluminum which forms over 8 per cent. None of the other metals forms as much as one tenth of one per cent. of the earth's crust.<sup>2</sup> Gold, copper, tin, silver, lead serve many purposes which could not be so well served by any other known substances, yet exhaustion of any one of them would soon be followed by a readjustment which would leave the modern world very much as it is now. Only two metals, then, aluminum and iron, are abundant enough to be really determining factors in directing civilization in its material aspects; and aluminum has not become such a factor, partly because the metal can not be separated cheaply from its most abundant compounds.

So accustomed have we become to the use of iron and steel for a multitude of uses that it scarcely occurs to us to ask—"Suppose iron had been a rare metal in the crust of the earth, as rare as gold or platinum, what then?" Suppose in the outworking of chemical and geological processes in the earth, iron, because of its high specific gravity, had been confined to the interior of our sphere, far from the reach of man! and suppose gold, or copper, or lead, had been so abundant as to force itself into man's operations in some such way as iron has done! As things have worked out, the material side of our present civilization is notably built up on iron. Iron possesses a marvelous range of possibilities which qualify it to serve a host of purposes which can not be served so well by anything else. From iron or steel are made the revolutionizing mechanisms or machines which have utterly changed the course of human history, mechanisms which in their various parts demand a combination of qualities of strength, elasticity, conductivity, high fusing point, rigidity, weight, or hardness which no other metal possesses.

#### THE EVER-INCREASING DOMINANCE OF IRON AND STEEL

And so we think, if we take the trouble to consider the matter, "How fortunate that such an indispensable metal is the second most abundant one in the crust of the earth!" Indispensable? Yes, in the sort of civilization which we are born into and which we account to be the best because it is ours.

<sup>2</sup> Certain metals such as calcium, magnesium, sodium and potassium exceed this amount, but they are seldom used except in their compounds and for chemical purposes.

Fairly reliable historical records reach back 6,000 years. The men who built the Great Wall of China or the pyramids, or the Taj Mahal; the men who wrote the epics and chiseled the statuary of Greece; the men who founded the great religions and philosophies that have gripped the world; the men who made the Roman eagles and Roman law and discipline irresistible—carried these aspects of civilization to limits which possibly lie even beyond our attainments in these lines in the twentieth century; yet among these men iron was almost a rarity. Its chief use was for weapons of war.

As a matter of fact, iron has held a commanding position only a century. In 1740 its yearly production, even in Europe, did not exceed two pounds per capita. During the present war, its production reached 800 pounds per capita in the United States. The extensive use of iron is by no means an essential of either a high or a powerful civilization. Yet it is the one thing above everything else which has directed the course and dominated the character of the present epoch on its material side.

#### ONLY A SMALL FRACTION OF THE WORLD HAS ABUNDANT IRON AND COAL

While iron is the second most abundant metal in the crust of the earth, the particular geo-chemical processes by which it has been concentrated in beds of high grade have occurred in relatively few places. Five sixths of the iron ore mined at present comes from small portions of four countries, the United States, Germany, England and France. There are four or five other known areas<sup>2</sup> with valuable deposits. Yet all these deposits, if brought together, could be included within the borders of a small American state. Low grade ores are more abundant. It is a matter of note that, with the single exception of China, none of the highly civilized nations either of antiquity or of the earlier middle ages contained important deposits of iron. It has already been pointed out that our civilization grew up in southwestern Asia and around the Mediterranean, lands poor in iron and still poorer in the fuel for smelting it. It does no violence to realities if we imagine men and nations living on and evolving ever higher planes of civilization in an environment without coal and with but little iron, as they did for thousands of years. The only purpose of thus imagining a condition contrary to fact is that certain conditions which actually

<sup>2</sup> In Brazil, Sweden, China, Russia.

do exist and under which we are living may be seen in their full significance.

A little different outworking of a few chemical and geological processes might have left the iron of the earth's crust widely diffused through the rocks and incapable of extensive use; or a little difference in the history of our planet might have left it, as most parts are left, without coal. But the events that really did happen gave certain parts of the earth coal and iron in enormous quantities, yet left much larger parts with little or none.

#### THE MARVELOUS RANGE OF UTILITY POSSESSED BY IRON

The great material developments of modern times have been directed in a remarkable degree by the range of possibilities afforded by the single metal iron, or more strictly speaking, the ferro-alloys. It is an impressive fact that certain of the most significant aspects of progress have been controlled and shaped along a very definite line; it has been progress in the fabrication of iron into tools, machines and engines of ever-widening variety and utility. Starting with the steam engine and progressing through all the marvelous expansion in the designing of machines of every kind, through the growth of means of communication and transportation on land and sea and in the air, means of destruction in war, means of diffusion of knowledge by the printing press, it is evident that the material progress of mankind is running mainly along those lines to which iron and steel have been devoted and to which they are peculiarly suited. There are, of course, scores of contributing factors—chemistry, metallurgy, mechanics, engineering, applications of electricity, and a long list of others—yet at every step these agencies find themselves achieving their conquests with the aid and the indispensable aid of iron and steel.

#### THE TRANSITION FROM STONE TO STEEL

Mankind stepped from an era in which his highest material achievements were in stone structures—to the era of machines which multiply human energy, speed and ability in hundreds of ways. It is the marvelous range of properties that can be imparted to iron by tempering and alloying that make it the incomparable metal. By slightly different methods of treatment or by adding small amounts of carbon, manganese, chromium, nickel, tungsten, or some other element, iron can be given almost any degree of hardness, brittleness, toughness,

elasticity, rigidity or strength, and thus made to meet almost any demand ranging from the hair spring of a watch to an armor-piercing projectile. With such a substance at his command, and easily available in practically unlimited amounts, man has unconsciously come to direct his energies and his inventiveness along lines served by this metal. An age of powerful engines, powerful ships, heavy guns, gigantic dredges, towering buildings, and other things of great weight and strength has come to pass; also an age of labor-performing machines which have given us our present industrial organization of society with all its ills and blessings.

#### CIVILIZATION IN ITS MATERIAL ASPECTS NOW UNDER A NEW CONTROL

With coal to supply him energy and with mechanisms that multiplied his power and his producing capacity enormously, the genius of man turned toward a new goal; not art, not architecture, not philosophy—but toward those activities in which the endless adaptations of the machine could best serve him. Master minds now found the opportunity for great achievement in a new field. The age when men of vision embodied their dreams in stone had largely passed. More and more, men of daring, of ability, of energy, saw their rewards lie in a new direction. There was no greater ability or vision than the Athenian possessed; no greater daring or energy than the Roman possessed, but opportunity of a hitherto unknown kind had developed and that opportunity and its reward lay in the activities which we term industry and commerce.

Iron and coal have not made our modern civilization. That is an outgrowth of centuries, molded and shaped by many forces and influences. It is not my desire to minimize any of the other influences which have given modern civilization its character. My purpose is to direct attention to two dominating influences: the influence of the *abundant* metal—iron, and the *abundant* fuel—coal, and to note the effect which the *abundance* of these minerals has had in determining the trend of civilization and in fixing the centers of wealth and of political and military power. The world has come under the domination of the peoples that have great reserves of coal and iron and know how to use them.